DUS&T Programs that Work
Heavy-Duty Hybrid Electric Propulsion

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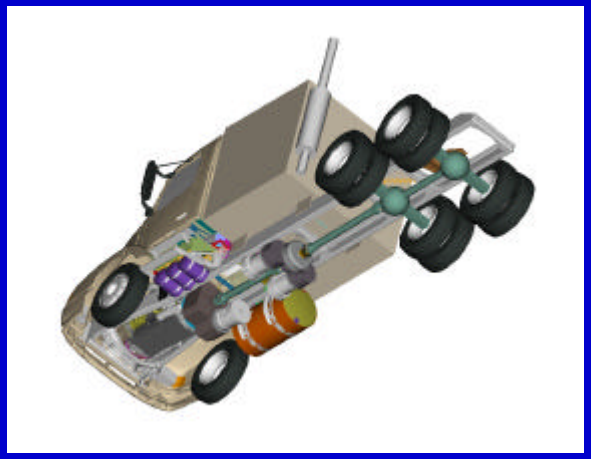
NAC/LMC Heavy Hybrid DUS&T Programs

FMTV Military Truck Program

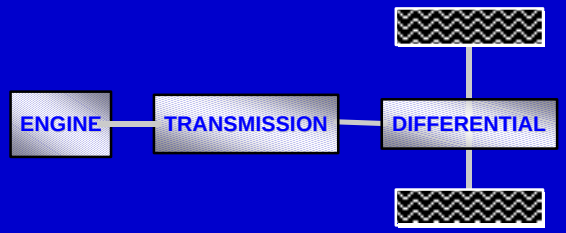
- Diesel Series Hybrid 5-ton FMTV
- DUS&T program Initiated 4Q98 (LMC prime)
- 2 - 250 hp AC Motors
- 330 hp Diesel Engine with 200kW Permanent Magnet Generator

Class 8 Tractor Program

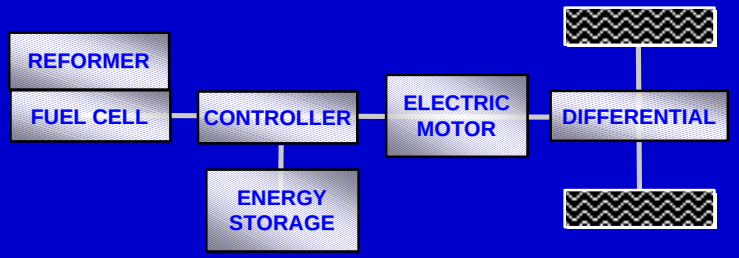
- Diesel Parallel Hybrid Class 8 Tractor
- DUS&T Program Initiated 2Q99 (through Radian Inc.)
- 2 - 250 hp AC Motors
- 460 hp Diesel Engine with 300 kW Induction Generator



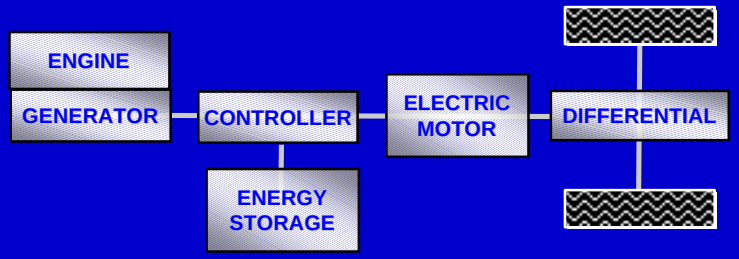
What Is A Hybrid Electric Vehicle (HEV)?



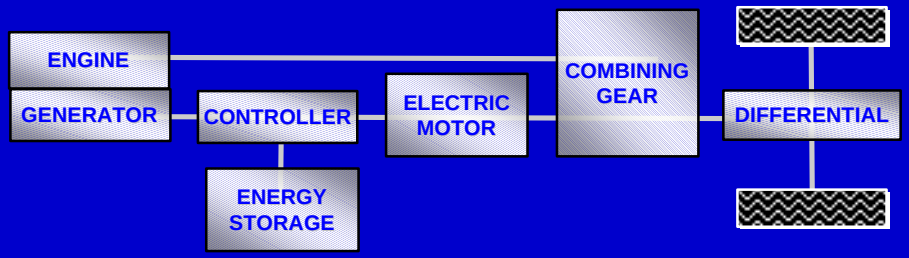
Traditional Drive Train



Fuel Cell Hybrid Drive Train



Series Hybrid Drive Train



Parallel Hybrid Drive Train

Hybrid Electric Propulsion Increases Efficiency by Decoupling the Engine from Wheel Speed

Dual Use Technology Benefits

Military Benefits

- 25% - 50% Better Fuel Economy
- Flexible Electrical Power Generation
- Reduced Signature (Stealth Mode)
- Improved Performance
- Reduced Maintenance (brakes, transmission)
- Uses Standard Fuels
- Similar to Today's Vehicles

Commercial Benefits

- Reduced Emissions (up to 90%)
- 25% - 50% Better Fuel Economy
- Improved Driveability, Quieter
- Improved Performance
- Reduced Maintenance (brakes, transmission)
- Uses Standard Fuels
- Similar to Today's Vehicles

Technology that Benefits *both* Military and Commercial Markets

FMTV DUS&T Program Objectives

Inverter/Motor Controller

- Reduce Size by Factor of Two
- Complete Redesign
- Developing a Single and a DUAL Controller/Inverter

Batteries

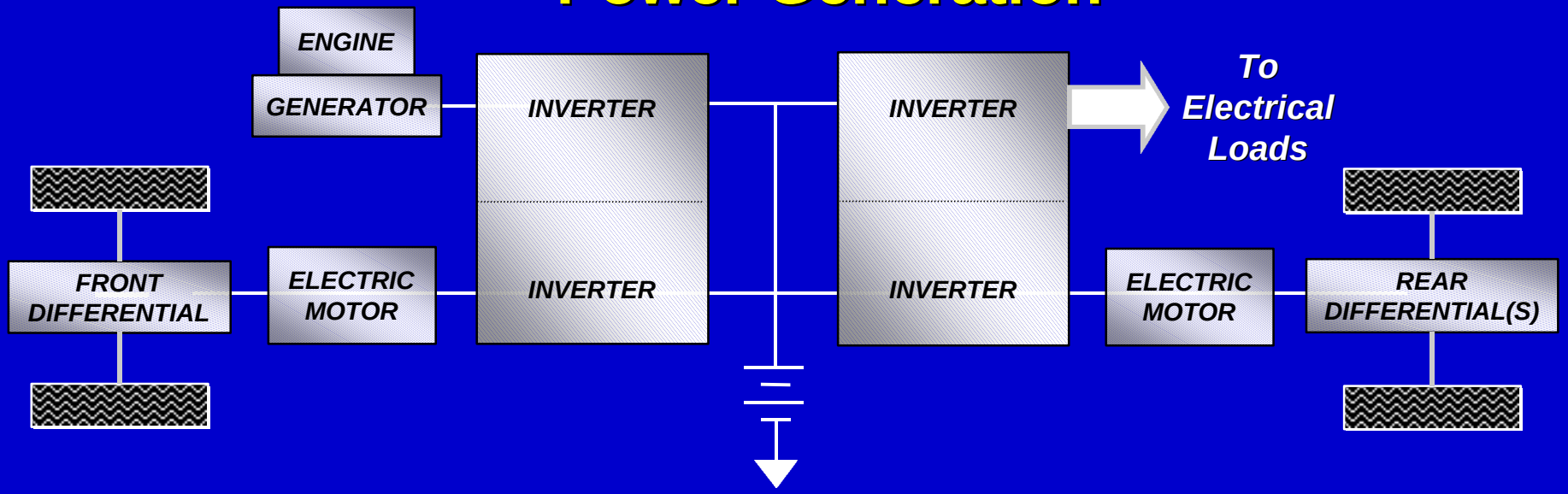
- Reduce Size and Weight by a Factor of Three
- Replace 85Ah Batteries with 26Ah batteries

Generator

- Increase Power to 200kW for full Mobility
- Switch to Liquid Cooling for Water Fording

Coming Soon!

New Dual Inverter Applied to Series HEV FMTV with Electrical Power Generation



- Two electric motors are used, one in the front, one in the rear
- The engine/generator supplies electricity to the motors for propulsion and the inverter for external electrical loads
- The battery stores excess energy from regenerative braking and releases it during vehicle acceleration
- Battery energy can be supplied to the inverter for power generation with the engine off (Silent Watch)

Dual-Use HEV Spiral Development Roadmap

Commercial Bus and Truck

Since 1996

Class 8 Truck DUS&T

1999

HEMTT / HET

M915 Hybrid Option

FMTV CRADA

1998

FMTV DUS&T

1999

FMTV Hybrid Option

HEV HIMARS / MEADS

Transit Bus Production

Summary

- Hybrid Electric Propulsion is Demanded by both Commercial and Military Applications
- Military and Commercial Applications Share many Common Benefits
- DUS&T is Improving the Technology for all Applications through Spiral Development
- Ideal 21st Century Truck Technology

HEV and the NAC - DUS&T Programs that Work!